

UNITED STATES DEPARTMENT OF AGRICULTURE

## FOREST SERVICE

Biological Evaluation  
of the  
Gypsy Moth Outbreak  
on the  
Allegheny National Forest  
Pennsylvania

1987



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BIOLOGICAL EVALUATION OF THE GYSPY MOTH  
OUTBREAK ON THE ALLEGHENY NATIONAL FOREST  
1987

SUMMARY

Severe gypsy moth defoliation occurred again on the Allegheny National Forest in 1987, with most on the Sheffield Ranger District. Some scattered mortality is beginning to appear on all three Ranger Districts. While populations have collapsed over most of the forest, some retreatment of 1987 spray blocks, and treatment of new blocks in one Entomological Area on the Sheffield Ranger District, and scattered populations in certain recreation areas and the Kane Experimental Forest, is recommended for the spring of 1988.

INTRODUCTION AND BACKGROUND

Over the past four years the area defoliated by gypsy moth (Lymantria dispar L.) has increased from a little over 2,000 acres to around 100,000 acres on the Allegheny National Forest. The Ridgway Ranger District has yet to receive any noticeable defoliation, with the worst infestations developing first on the Marienville and Bradford Ranger Districts and affecting mostly the Sheffield Ranger District in 1987. The distribution of defoliation by year and ranger district is summarized below:

Gypsy Moth Defoliation - All Ownerships

Ranger District	1984	1985	1986	1987
	-----ACRES-----			
Bradford	0	4799	41,313	6160
Marienville	2024	4000	20,311	6880
Sheffield	0	843	16,441	102,600
TOTALS	2024	9642	78,065	115,640

It should be noted that 1985 and 1986 defoliation was determined from high altitude aerial photography, while 1984 and 1987 defoliation were from aerial sketchmapping. Lack of detail inherent in the latter method caused the inclusion of some small undefoliated areas within the generally defoliated areas and probably exaggerated the affected acreage somewhat. Maps 1 through 3 of Appendix A show the defoliated areas as sketched late in June of 1987. Table 1 details the defoliated areas by ownership and severity class on each of the Ranger Districts.

OBJECTIVE

As in previous years, areas were surveyed that by nature of their oak component are presumed to be susceptible to gypsy moth defoliation. Areas that are predominately northern hardwood or Allegheny hardwood are not expected to sustain populations of gypsy moth that cause more than minimal damage. Egg

mass surveys were conducted in susceptible timber types to determine where the level of infestation was high enough to cause moderate to heavy defoliation (greater than 30% of the foliage stripped from the canopy) in 1988. Surveys of certain additional high use recreation areas were conducted despite their lack of oak timber type, because of the nuisance to users and potential for transportation of larvae associated with these areas. Included were the Twin Lakes, Beaver Meadows and Loleta Recreation Areas. Certain stands in the Kane Experimental Forest were also checked because of their proximity to the high population in the Twin Lakes area and research's sensitivity to defoliation altering tree growth in experimental plots especially with recent defoliation by the cherry scallop shell moth.

#### SURVEY PROCEDURE

Each Ranger District was divided into "Entomological Areas" containing between 1,400 and 10,000 acres of Forest Service land and several compartments with significant oak components. These entomological areas and their corresponding compartments are shown on Maps 4-14 and acreage in Forest Service ownership shown on Table 5 of Appendix B. Sixteen 1/40 acre, circular plots were distributed throughout each Entomological Area. These plots were placed in the same general locations as in the 1986 survey, except where areas had been sprayed in the 1987 suppression project; sprayed plots were replaced by adding new plots in other locations. Additional plots were added to Ento Area S-8 (south of Dunham Siding) because of some additional acres in this area, and some perceived "hot spots" in exceptionally high quality red oak stands. All new egg masses were counted within these plots and used to calculate egg masses per acre. An average number of egg masses per acre with 95% confidence limits are presented for each of the entomological areas in Table 2, Appendix B.

Additional information taken at these sample plots included the approximate percentage of oak in the stand by percent cover (to help interpret variations in egg mass counts), the general size of the egg masses and the presence of parasites (Ooencyrtus wasps) on the egg masses. These latter two give an indication of the health of the population and whether it is declining or increasing.

In areas not sampled before (outside the entomological areas), specifically the recreation areas named above and the Kane Experimental Forest, a different sampling technique was used. Egg mass counts taken in a 5-minute walk were correlated to egg masses per acre using regression formulae developed by Eggen and Abrahamson at the SUNY College of Environmental Science and Forestry at Syracuse, NY. These areas are shown on Map 15, Appendix B and the resulting estimates are presented in Table 4, Appendix B.

The main advantage of the 5-minute walk technique is that it can cover a wider range of forest variability in a shorter amount of time to determine threshold populations. It is especially useful in areas such as Twin Lakes and Loleta Recreation Areas, where egg masses can be concentrated on a few open grown trees. The chance inclusion of these trees in fixed radius plots can either miss these trees or areas or cause wide variability in observations within a given area. While the fixed-radius plots were used to maintain continuity with last year's survey, we plan to compare these results with those obtained from additional 5-minute walks to determine which is the most effective survey technique in generally forested areas.

## OBSERVATIONS

In the areas of the Allegheny National Forest most severely defoliated during the past few years, gypsy moth populations have either collapsed or are declining. In portions of these areas, however, populations still exist at higher than expected densities. This appears to be due to the limited population reduction obtained from the use of Bacillus thuringiensis in the 1987 spray project. Presumably, the surviving larvae in the sprayed areas had less competition for food and were less susceptible to the viral disease that caused the natural collapse of the general population. Correlations between egg mass density and defoliation of host type have been presented by David Gansner, NEFES, Broomall, and were used to predict the potential 1988 defoliation; greater than 750 egg masses per acre can be expected to cause moderate defoliation (30-60%) and greater than 1500 egg masses per acre can result in severe defoliation (60-100%). Potential defoliation for each of the Entomological Areas is presented in Table 3 of Appendix B. About 15 percent of the Sheffield Ranger District is predicted to receive extensive moderate defoliation, the rest of the Entomological Areas should receive generally light defoliation. Aside from the treated areas, the only Entomological Area still supporting moderate or severe defoliating populations is S-8. Ento Areas M-5, M-6 and S-10 are marginal for this defoliation intensity depending on which end of the confidence interval is used. It does not appear that any large areas will be severely defoliated in 1988. Populations in Entomological Areas M-7, M-8, R-1 and R-2 (along the Clarion River) are up slightly from last year but in general are below defoliating levels. A specific timber sale area west of Entomological Area M-7 on the Marienville District was sampled with two five-minute walks and was found to contain a potentially defoliating population in about half the area.

## PEST MANAGEMENT ACTION

The most practical alternative actions for dealing with the gypsy moth outbreak on the ANF in 1987 and in future years (as appropriate) involve the range of alternatives developed from the 1987 Environmental Assessment prepared by an interdisciplinary team of the ANF and FPM personnel. These alternatives can be summarized as follows and are to be applied to compartment(s) and recreation areas which will experience moderate to severe defoliation in 1988.

1. No suppression, but may salvage timber which may die as a result of defoliation.
2. Treatment with biological insecticide to protect trees on developed recreation sites and reduce larval nuisance and hazard tree risk to recreationists, (threshold limit 500 EM/AC).
3. Treatment with biological and/or chemical insecticide as appropriate to protect high-value oak timber stands that were thinned in the last five years or that may be thinned or harvested in the next five years, (threshold limit 750 EM/AC) and especially those spray blocks unsuccessfully treated in 1987 (threshold limit 500 EM/AC).
4. Combination of Alternative 2 and 3.



5. Alternative 3 plus treatment of low-value oak timber stands with a chemical insecticide to reduce the build-up and spread of gypsy moth in subsequent years from stands which currently have very high egg mass counts.
6. A combination of 2 and 5.
7. Alternative 6, but treatment material exclusively a biological insecticide.

The following discussion of the alternative identified above does several things: (1) anticipates the degree of resource protection from each; (2) provides other positive and negative features of each; (3) estimates the time before retreatment; and (4) identifies our preferred alternative.

The alternative involving no suppression will not protect any resource value whereas suppression actions of aerially applying insecticides will prevent moderate to severe defoliation and mortality of forest trees. Usually, about 20-40 percent of the basal area is killed within five years following two to three consecutive years of moderate to severe defoliation in unmanaged stands compared to 30-90 percent of the residual stocking dying in thinned stands with the same defoliation history. Spraying has other positive benefits including reducing larval densities to innocuous levels thereby reducing the spread of gypsy moth in subsequent years from treated forest areas into adjacent untreated ones. The only benefits of no suppression would accrue to wildlife species which can take advantage of an abundance of food and whose habitats are defined by sparse tree stocking, more canopy openings, increased presence of snags or increased presence of forbs and shrubs.

Without any suppression, the present gypsy moth outbreak will not continue indefinitely but will run its course with the next year or two on the Allegheny NF. The gypsy moth has now established itself in the forest ecosystem, and has caused moderate to severe defoliation for two or three successive years in most parts of the oak forest type. Natural population collapse typically comes from an epizootic of the naturally occurring gypsy moth virus following a period of starvation brought on by total consumption of available food. This situation has now occurred throughout much of the Allegheny National Forest.

Forested areas where the microbial B.t. are applied generally have a higher residual gypsy moth population than equivalent areas treated with chemical Dimilin. Consequently, retreatment might be needed the next year in about one-quarter of the B.t. treated areas. However, spray block size and shape relative to adjacent population densities sometimes necessitate retreatment even in Dimilin sprayed areas. The period of potential annual retreatment should not exceed the duration of the outbreak phase (1-3 years) of the typical gypsy moth population cycle.

#### PREFERRED ALTERNATIVE

Our preferred alternative for dealing with the current gypsy moth outbreak on your Forest involves actions consistent with resource management objectives and values at risk. Thus, suppression of the outbreak should be considered for any high-value oak stand and high-use recreation site occurring in Entomological Areas where the trend in resident gypsy moth populations remain static at high densities or expected to increase and cause moderate or severe defoliation. Even Entomological Areas where a decreasing population trend is expected to

result in light defoliation from low density resident populations, candidate areas for spraying may exist if there is a high potential for massive blow-in of 1st instar larvae from an outbreak area within a mile or two.

In conclusion, we prefer: 1) the use of B.t. in certain developed recreation areas applied once at maximum dosage to high density healthy populations; 2) Dimilin or B.t. in specific high-value oak timber stands thinned within the last five years or planned to be cut within the next five years. Extremely dense populations of gypsy moth in low-value, low-use forested areas would be left to collapse from natural controls where this has not occurred already. Alternative 4 provides this pest management approach emphasizing suppression treatments only where they are urgently needed to protect the highest resource values currently under the greatest risk from the gypsy moth outbreak. Treatments being considered are biologically the most effective, environmentally the most acceptable, and economically the most beneficial.

Ranger District	Total Acreage Surveyed	Average Defoliation Potential by Intensity Class		
		Light	Moderate	Severe
-----Percent-----				
Bradford	67,415	100	0	0
Marienville	34,125	100	0	0
Ridgway	11,752	100	0	0
Sheffield	66,546	85	15	0
Allegheny NF	179,838	94	6	0

From Appendix B, Tables 3 and 4, we believe it is possible to obtain a more localized idea about the infestation trend and average defoliation expected in susceptible host type within each Entomological Area. The average defoliation class and the range of classes are based on the average egg mass density per acre and its confidence interval (C.I.) set at 5 percent probability. For example, the susceptible oak forest within the 10,100 acres of Sheffield Entomological Area-8 would, on the average, experience moderate defoliation as the gypsy moth population there should remain fairly abundant in 1987. Using the C.I. for average egg mass density, moderate defoliation there seems inevitable as the lower limit of the estimate remains very close to the moderate threshold.

#### CONSEQUENCES OF THE OUTBREAK ON FOREST RESOURCES

Recreational Areas predicted to experience moderate to severe defoliation would be adversely affected by the nuisance and aesthetic degradation caused by massive numbers of larvae next spring. Tree defoliation with resultant tree mortality can permanently affect the recreational setting by first denying users the green, shaded forest environment they expect and later by increasing the risk to recreationists from hazard trees.

Permanent damage to timber producing stands from gypsy moth outbreaks is most acute where trees are moderately to severely defoliated for several successive years. Tree mortality may occur sooner in previously thinned stands managed for timber values. However, the influence of past cutting activity and residual stocking, together with the onset of defoliation and its intensity and frequency on subsequent tree mortality, have yet to be fully documented by forest pest management surveys or elucidated by research study plots.

It should be noted that certain areas on the Allegheny National Forest were moderately to severely defoliated in 1987 even though they were sprayed. Those areas still containing populations exceeding 500 egg masses per acre should receive special attention, as they may have received 2 years of defoliation already and have previously been identified as vulnerable areas.

## APPENDICES

This index lists the tables and maps contained in each appendix to this report.

### APPENDIX A

Table 1. 1987 Gypsy Moth Defoliation by Ranger District and Severity Class, Allegheny National Forest (1 page).

Maps 1-3. 1987 Gypsy Moth Defoliation, Allegheny National Forest, by Ranger District (3 pages)

### APPENDIX B

Table 2. 1987 Gypsy Moth Egg Mass Survey Results, Allegheny National Forest (2 pages).

Table 3. 1988 Gypsy Moth Predictions, Allegheny National Forest (2 pages).

Table 4. 1987 Gypsy Moth Egg Mass Surveys, Miscellaneous Areas Sampled, Allegheny National Forest (1 page).

Maps 4-14. 1987 Gypsy Moth Egg Mass Survey Entomological Areas, and Compartments Surveyed, by Ranger District (11 pages).

Map 15. 1987 Gypsy Moth Egg Mass Surveys, Miscellaneous Areas Sampled, Allegheny National Forest.

APPENDIX A



Table 1. 1987 Gypsy Moth Defoliation by Ranger District and Severity Class, Allegheny National Forest (1 page).

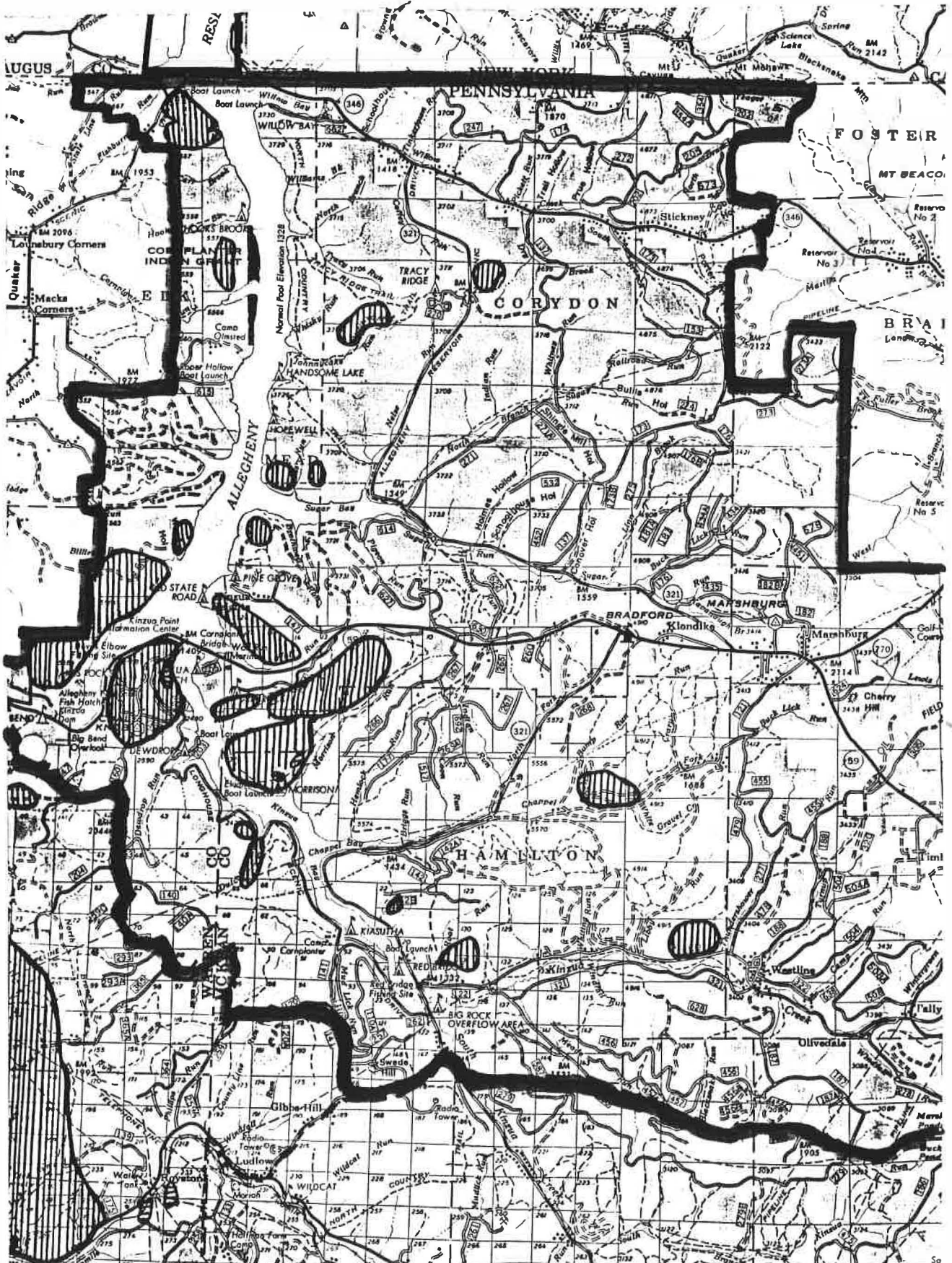
Maps 1-3. 1987 Gypsy Moth Defoliation, Allegheny National Forest, by Ranger District (3 pages)

Table 1.--1987 Gypsy Moth Defoliation by Ranger District, Ownership and Severity Class. Allegheny National Forest.

Ranger District and Ownership	Acres by Defoliation Class		
	Moderate	Severe	Total
Bradford	6040	120	6160
--Forest Service Land	5560	120	5680
--State & Private Land	480	0	480
Marienville	6880	0	6880
--Forest Service Land	5560	0	5560
--State & Private Land	1320	0	1320
Sheffield	67,840	34,760	102,600
--Forest Service Land	41,000	22,680	63,680
--State & Private Land	26,840	12,080	38,920
Allegheny NF	80,760	34,880	115,640
--Forest Service Land	52,120	22,800	74,920
--State & Private Land	28,640	12,080	40,720


Map 1.--1987 Gypsy Moth Defoliation, Allegheny National Forest,  
Bradford Ranger District

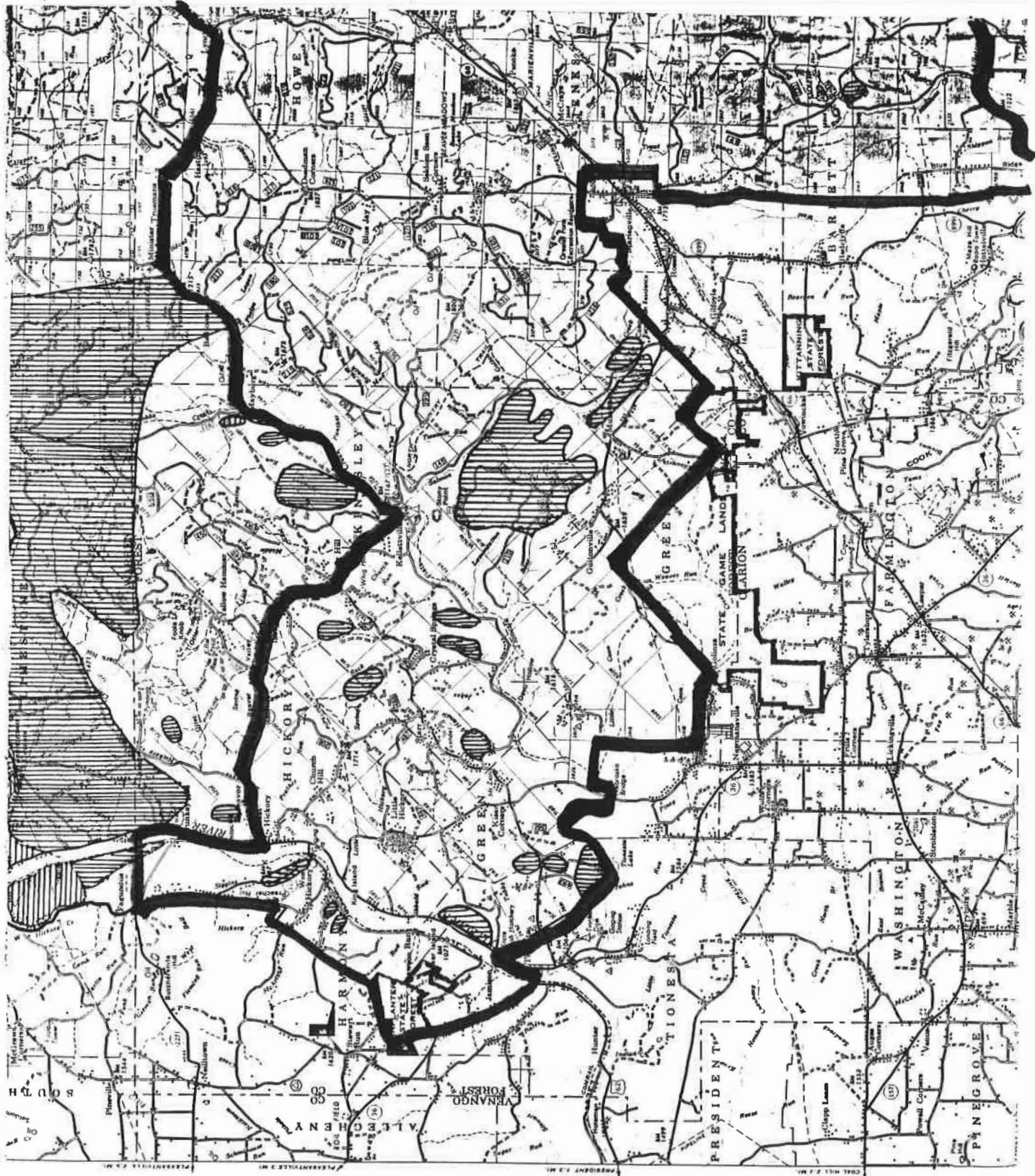
 Moderate (30-60%) 6040 acres  
 Severe (60-100%) 120 acres







Map 2.--1987 Gypsy Moth Defoliation, Allegheny National Forest,  
Marienville Ranger District

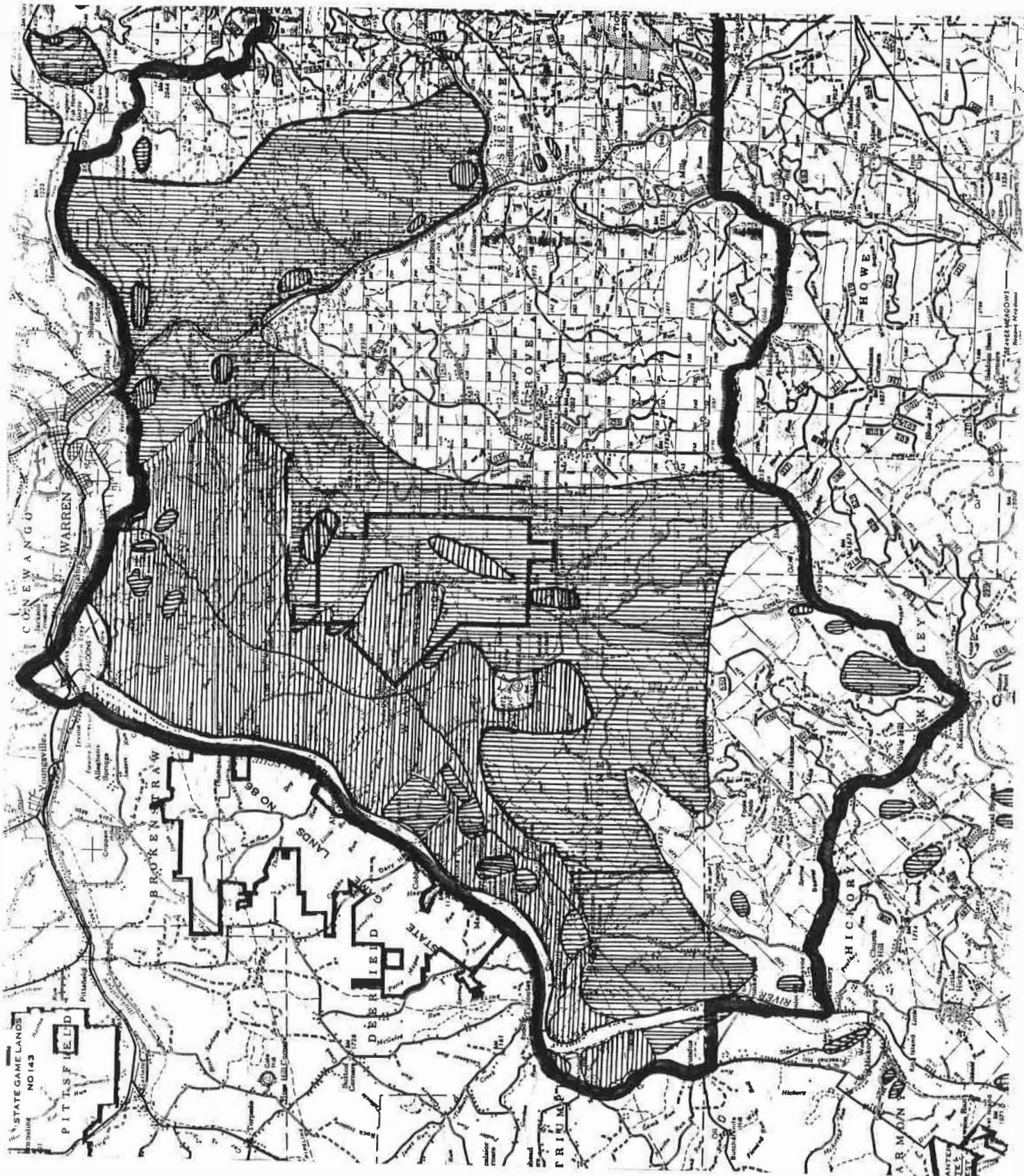
 Moderate (30-60%) 6,680 acres





Map 3.--1987 Gypsy Moth Defoliation, Allegheny National Forest,  
Sheffield Ranger District

 Moderate (30-60%) 67,840 acres  
 Severe (60-100%) 34,760 acres



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Table 2.--1987 Gypsy Moth Egg Mass Survey Results, Allegheny National Forest.  
Bradford Ranger District

ENTO AREA	AVERAGE EGG MASSES/AC ± CL	EGG MASS SIZE	APPROX % OAK ON PLOTS	% OF PLOTS WITH PARASITES	1987-1988 POPULATION TREND
B-1	155 ± 78	Large	50	10	Decreasing
B-2	130 ± 79	Small/Medium	15	50	"
B-3	486 ± 196	Medium	75	75	"
B-4	103 ± 83	Medium	< 1	80	"
B-5	145 ± 101	Medium	< 1	25	"
B-6	416 ± 262	Large	75	95	"
B-7	125 ± 25	Large	60	70	"
B-8	10 ± 7	Large	0	0	"
B-9	43 ± 19	Medium	0	10	"
B-10	113 ± 58	Medium	70	60	"
B-11	43 ± 20	Large	2	0	"
B-12	58 ± 26	Medium/Large	2	10	"

Table 2.--1987 Gypsy Moth Egg Mass Survey Results, Allegheny National Forest.  
Marienville Ranger District

ENTO AREA	AVERAGE EGG MASSES/AC ± CL	EGG MASS SIZE	APPROX % OAK ON PLOTS	% OF PLOTS WITH PARASITES	1987-1988 POPULATION TREND
M-1	265 ± 149	Large	70	50	Decreasing
M-2	107 ± 57	Large	65	60	"
M-3	183 ± 51	Large	75	60	"
M-4	127 ± 46	Large	75	20	"
M-5	720 ± 350	Medium/Large	55	70	"
M-6	685 ± 303	Medium/Large	45	45	"
M-7	480 ± 193	Medium/Large	70	60	Increasing
M-8	410 ± 162	Medium/Large	60	25	"
M-9	203 ± 89	Large	45	50	Decreasing
M-10	78 ± 46	Large	80	70	"

Table 2.--1987 Gypsy Moth Egg Mass Survey Results, Allegheny National Forest.  
Ridgway Ranger District

ENTO AREA	AVERAGE EGG MASSES/AC ± CL	EGG MASS SIZE	APPROX % OAK ON PLOTS	% OF PLOTS WITH PARASITES	1987-1988 POPULATION TREND
R-1	193 ± 40	Large	30	0	Increasing
R-2	143 ± 55	Medium/Large	40	50	"

Table 2.--1987 Gypsy Moth Egg Mass Survey Results, Allegheny National Forest.  
Sheffield Ranger District

ENTO AREA	AVERAGE EGG MASSES/AC ± CL	EGG MASS SIZE	APPROX % OAK ON PLOTS	% OF PLOTS WITH PARASITES	1987-1988 POPULATION TREND
S-1	211 ± 127	Medium/Large	70	80	Decreasing
S-2	520 ± 225	Small/Medium	70	95	"
S-3	115 ± 53	Small	95	50	"
S-4	133 ± 92	Small	75	100	"
S-5	307 ± 90	Small/Large	80	90	"
S-6	205 ± 90	Small/Large	75	50	"
S-7	333 ± 197	Large	70	90	"
S-8	1075 ± 356	Large	70	100	"
S-9	173 ± 79	Large	65	80	"
S-10	668 ± 379	Large	75	80	"
S-11	280 ± 138	Large	85	0	"
S-12	113 ± 110	Medium/Large	25	0	"
S-13	310 ± 191	Medium/Large	0	90	"

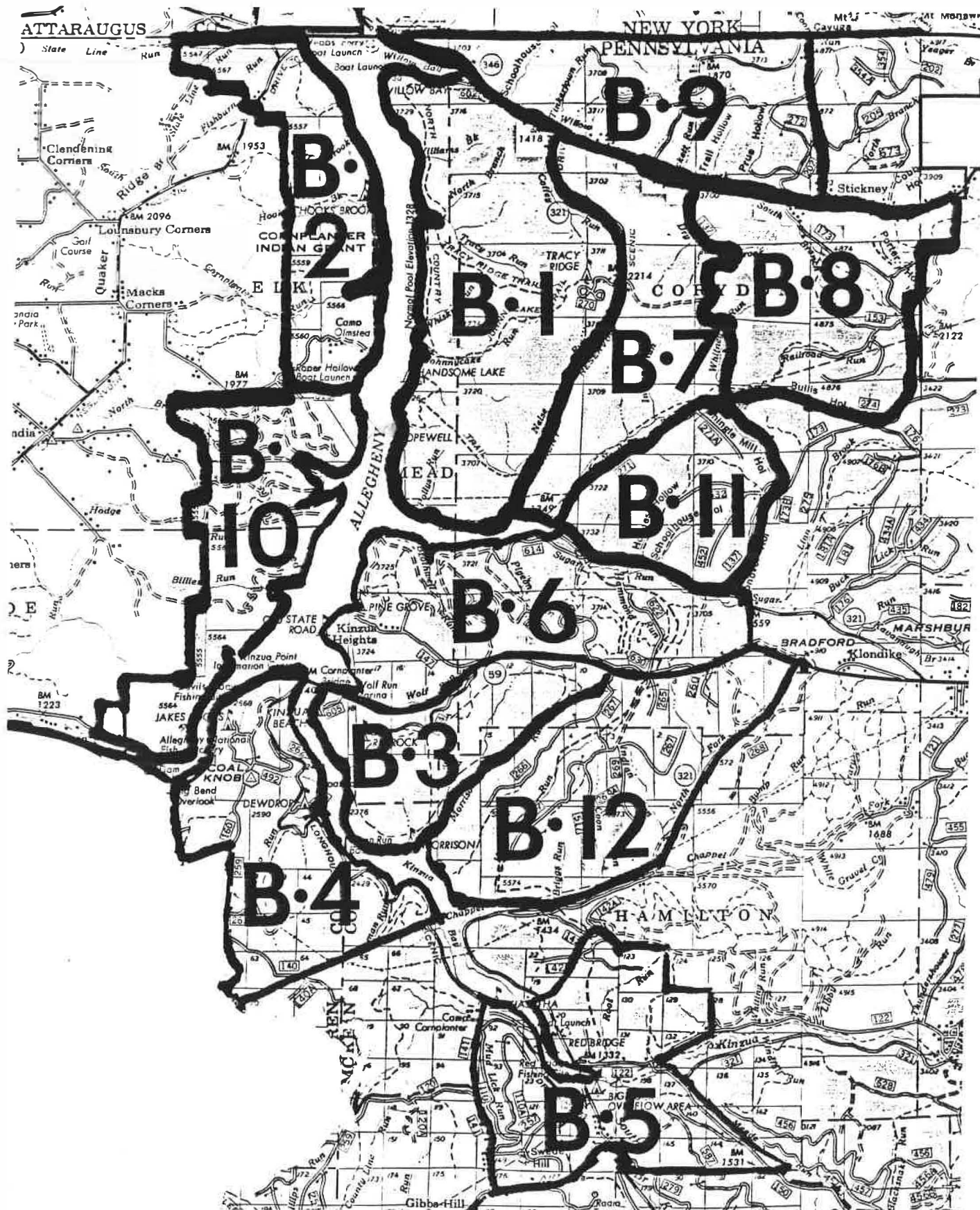
Table 3.--1988 Gypsy Moth Outbreak Predictions, Allegheny National Forest,

ENTO AREA	COMPARTMENT NUMBERS	NET ACREAGE	AVERAGE	RANGE
Bradford Ranger District		67,415		
B-1	9-17	9,188	Light	Very Light/Light
B-2	95-97	4,073	Light	Very Light/Light
B-3	46-49	4,805	Light	Light
B-4	86-90	5,943	Light	Very Light
B-5	57,58,76,94	5,042	Light	Very Light/Light
B-6	41-44	5,886	Light	Very Light/Light
B-7	18,20-23	4,967	Light	Very Light
B-8	24-28,30	4,344	Light	Very Light
B-9	1-4	6,078	Light	Very Light
B-10	98-100	5,330	Light	Very Light
B-11	31,34-35	4,392	Light	Very Light
B-12	50-54	6,367	Light	Very Light
Marienville Ranger District		34,125		
M-1	1-4,6	3,946	Light	Very Light/Light
M-2	5,7-10	2,559	Light	Very Light
M-3	13,14,17	2,392	Light	Very Light/Light
M-4	12,16,18,19	2,223	Light	Very Light
M-5	15,20,21,25	3,711	Light	Light/Moderate
M-6	22-24,28	5,284	Light	Light/Moderate
M-7	65-67,77,90,91	4,126	Light	Light
M-8	92,105,106	3,815	Light	Light
M-9	29-32	4,680	Light	Very Light/Light
M-10	117-118	1,389	Light	Very Light
Ridgway Ranger District		11,572		
R-1	109-113	6,172	Light	Very Light/Light
R-2	92,104-106,114	5,580	Light	Very Light
Sheffield Ranger District		66,546		
S-1	1,2,4-7	4,239	Light	Light
S-2	8,9,18-20	4,543	Light	Very Light
S-3	21-24,28,29	5,787	Light	Very Light
S-4	3,25-27,49-52	7,790	Light	Very Light/Light
S-5	81-85,128,129	4,028	Light	Very Light/Light
S-6	53-55,77-78,87	4,093	Light	Very Light/Light
S-7	130-133,148	5,819	Light	Very Light/Light
S-8	76,89-91,118-121 141,155	10,010	Moderate	Light/Moderate
S-9	137-138,146-147	3,165	Light	Very Light/Light
S-10	139-140,142,144,145	3,886	Light	Light/Moderate
S-11	150-154	4,041	Light	Very Light/Light
S-12	10-16	7,136	Light	Very Light/Light
S-13	34-35	2,009	Light	Very Light/Light

Table 4.--1987 Gypsy Moth Egg Mass Surveys, Miscellaneous Areas Sampled,  
Allegheny National Forest

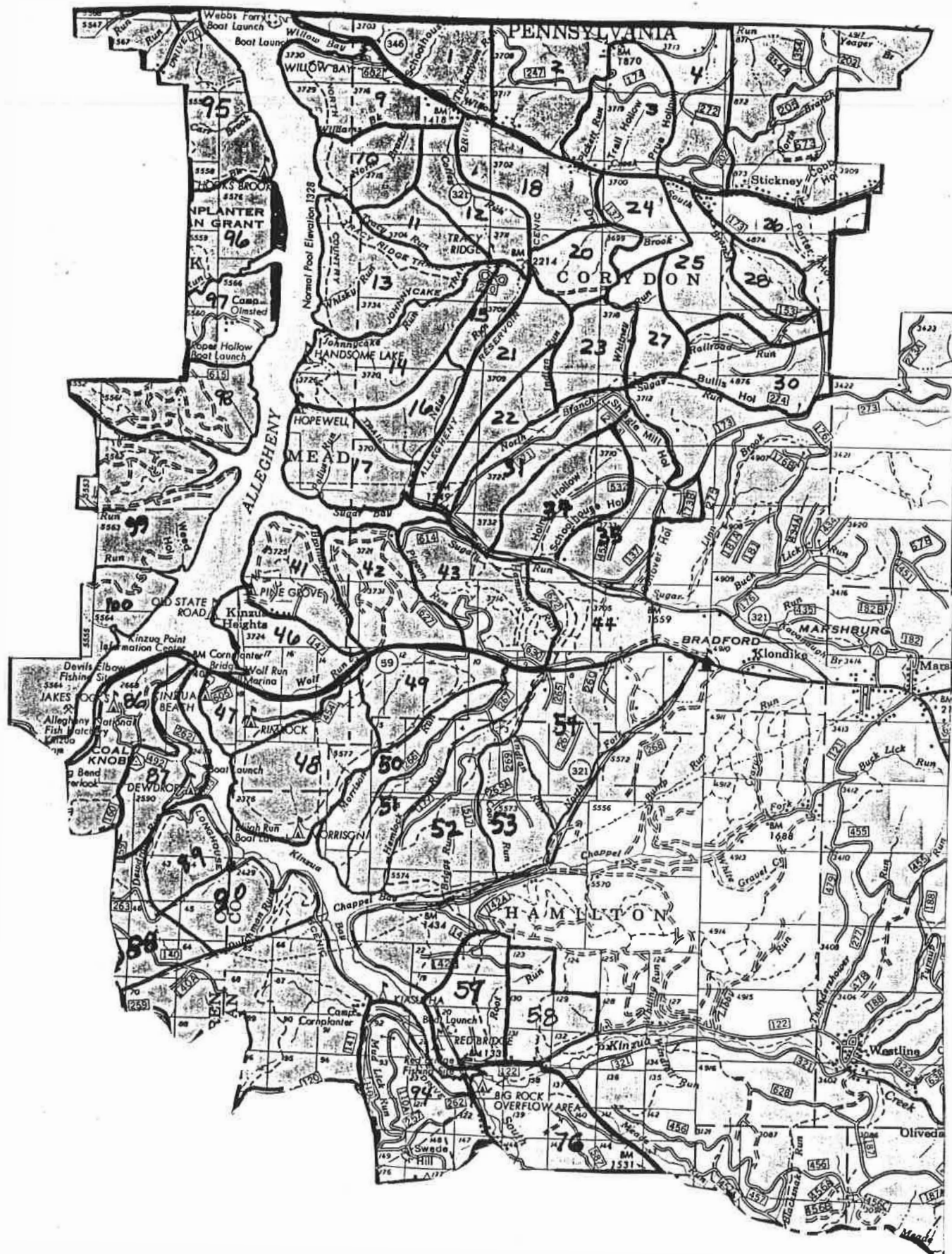
	EGG MASSES/AC	EGG MASS SIZE	PARASITES PRESENT	1987-1988 POPULATION TREND
Beaver Meadows RA	650	Large	No	Increasing
Loleta RA	612-650	Large	No	"
Twin Lakes RA	870-2000	Large	No	"
Kane Experimental Forest	<500-916	Large	No	"

Map 4.--1987 Gypsy Moth Egg Mass Survey Entomological Areas  
Allegheny National Forest, Bradford Ranger District



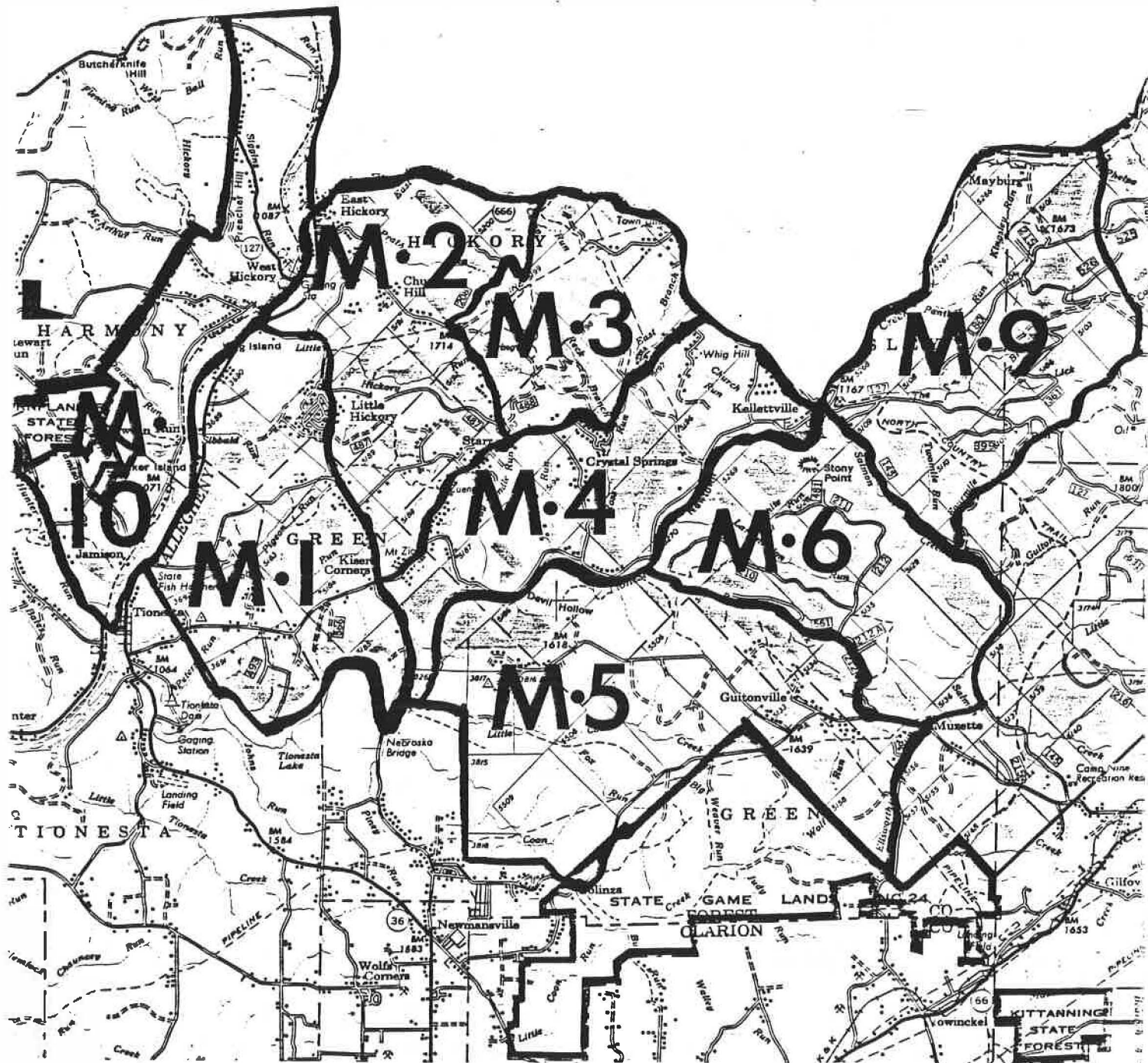


Map 5.--1987 Gypsy Moth Egg Mass Survey Compartments  
Allegheny National Forest, Bradford Ranger District

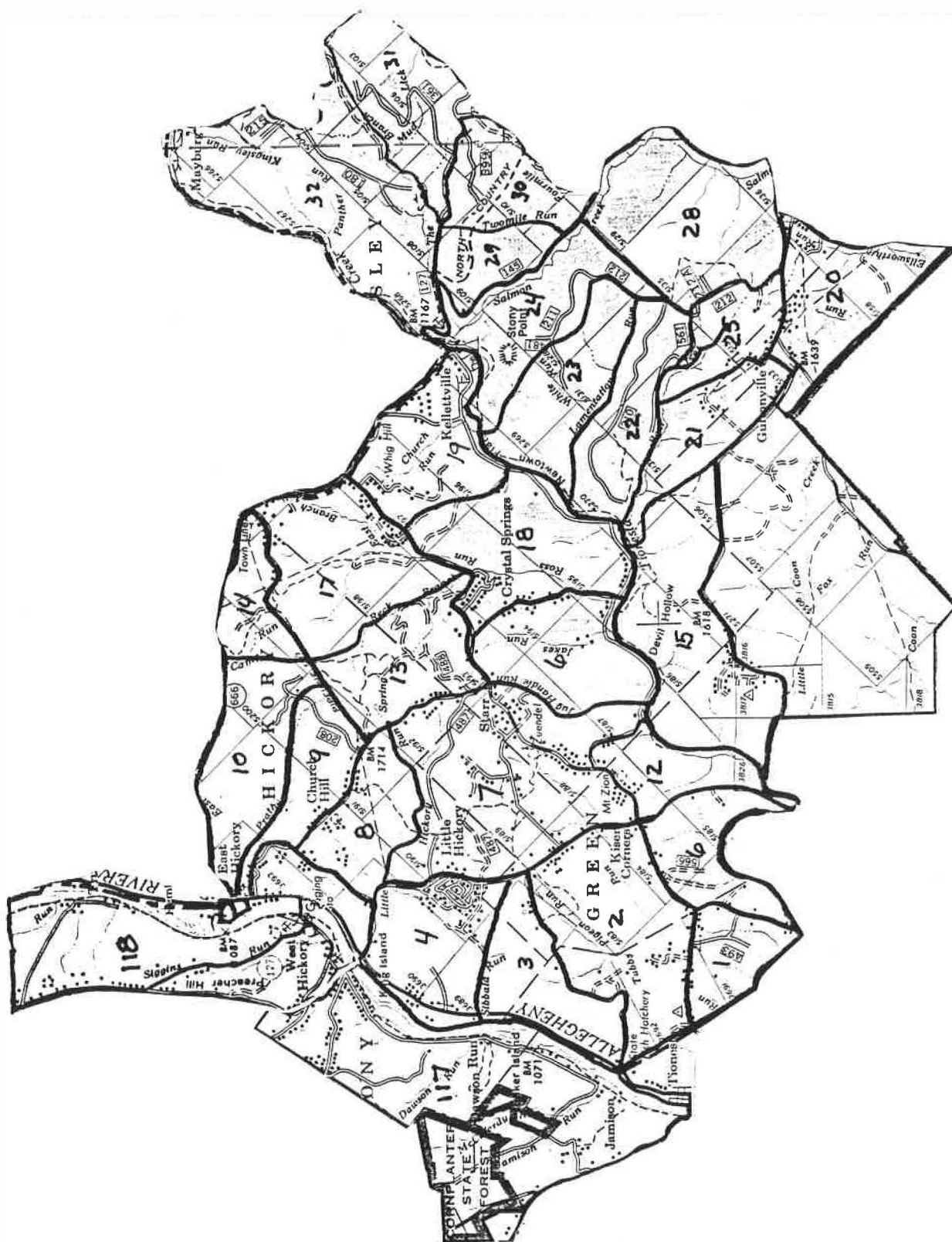




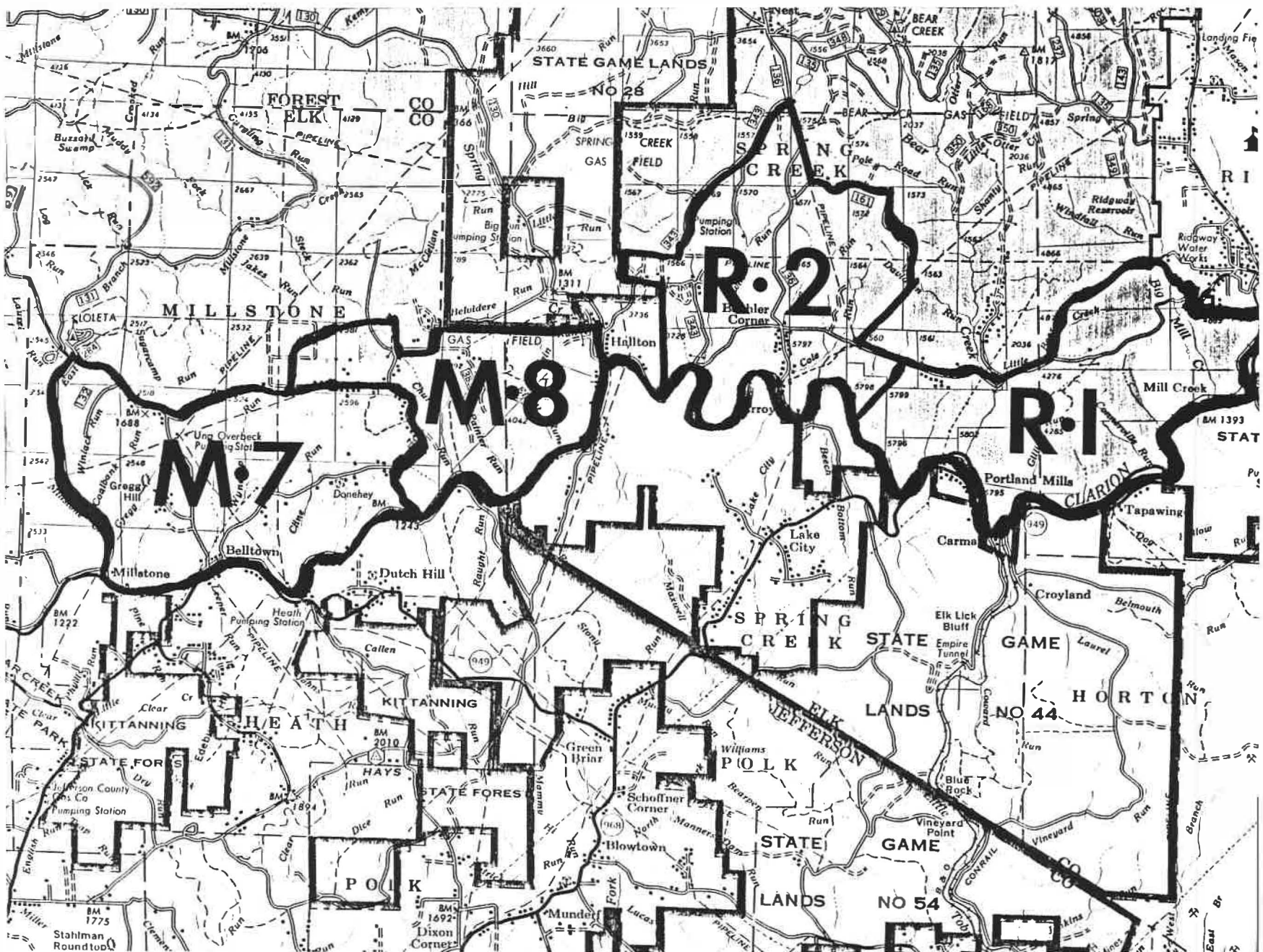
Map 6.--1987 Gypsy Moth Entomological Areas, Allegheny National Forest, Marienville Ranger District



Map 7.--1987 Gypsy Moth Egg Mass Survey Compartments  
Allegheny National Forest, Marienville Ranger District



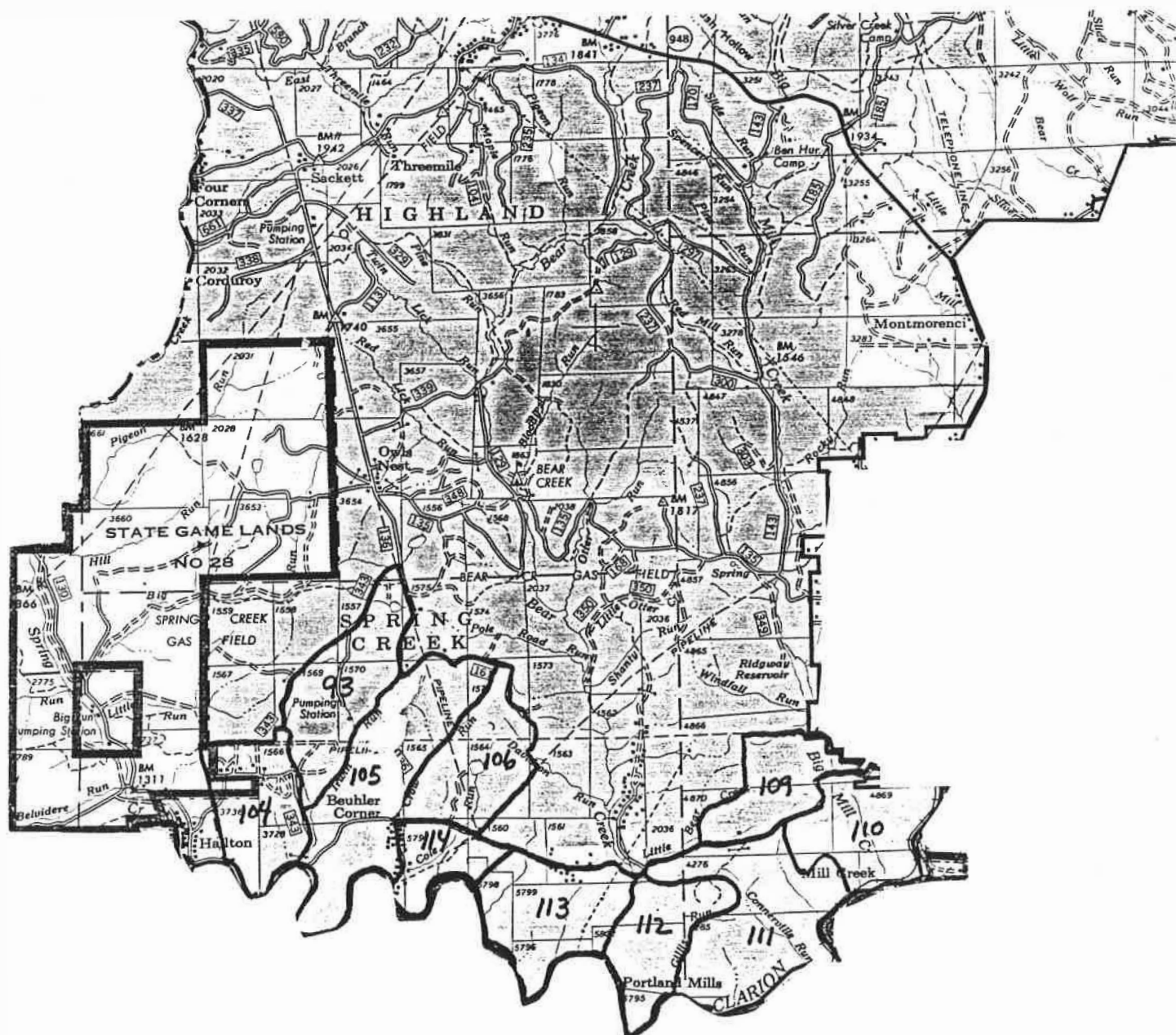
Map 8.--1987 Gypsy Moth Egg Mass Survey Entomological Areas,  
Allegheny National Forest, S.E. Marienville and Ridgway Districts



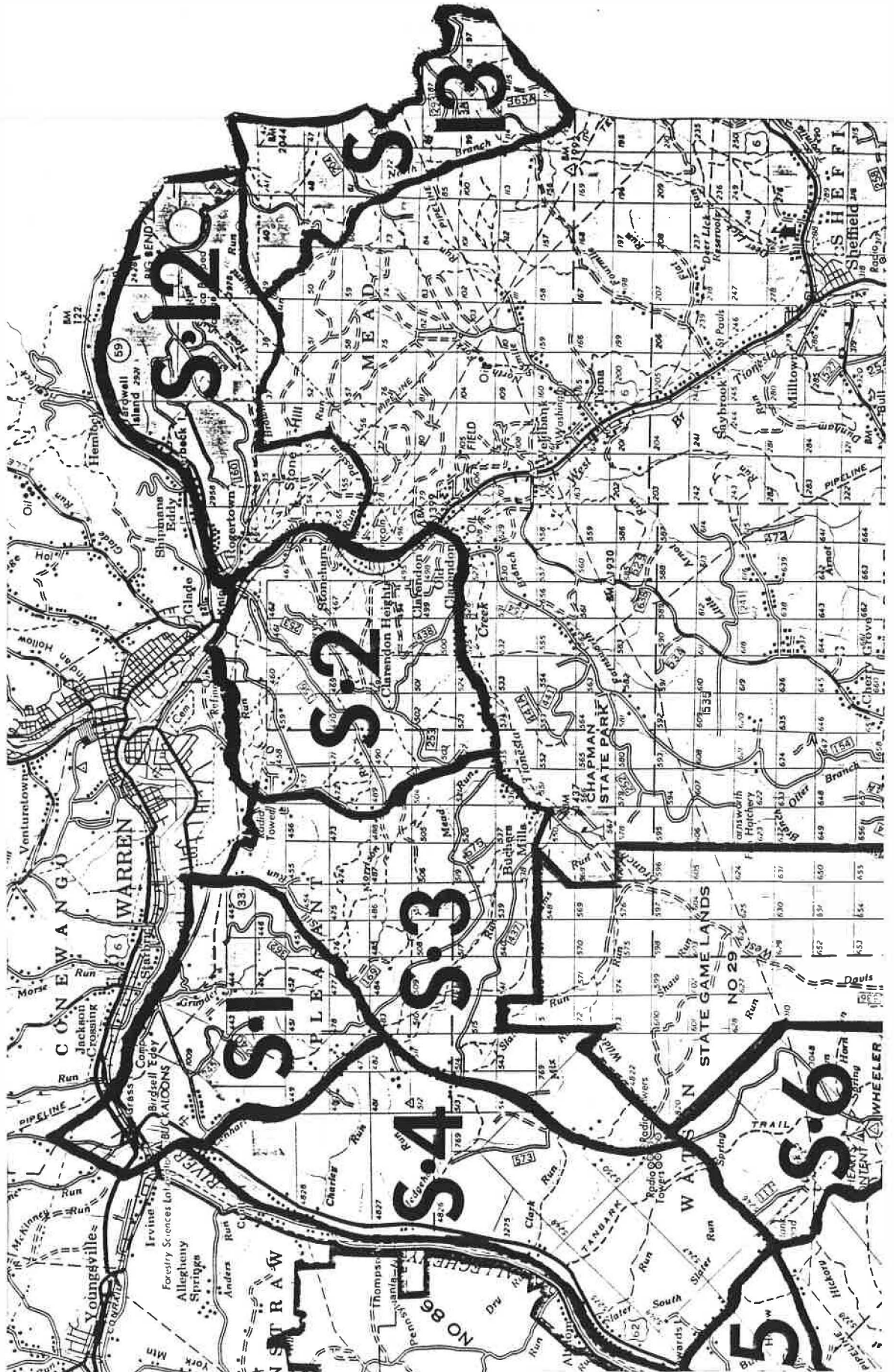


This is a detailed topographic map of a section of Elk County, Colorado. The map shows a network of roads, including Highway 66 and several numbered routes (127, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925,

Map 10.--1987 Gypsy Moth Egg Mass Survey Compartments  
Allegheny National Forest, Ridgway Ranger District



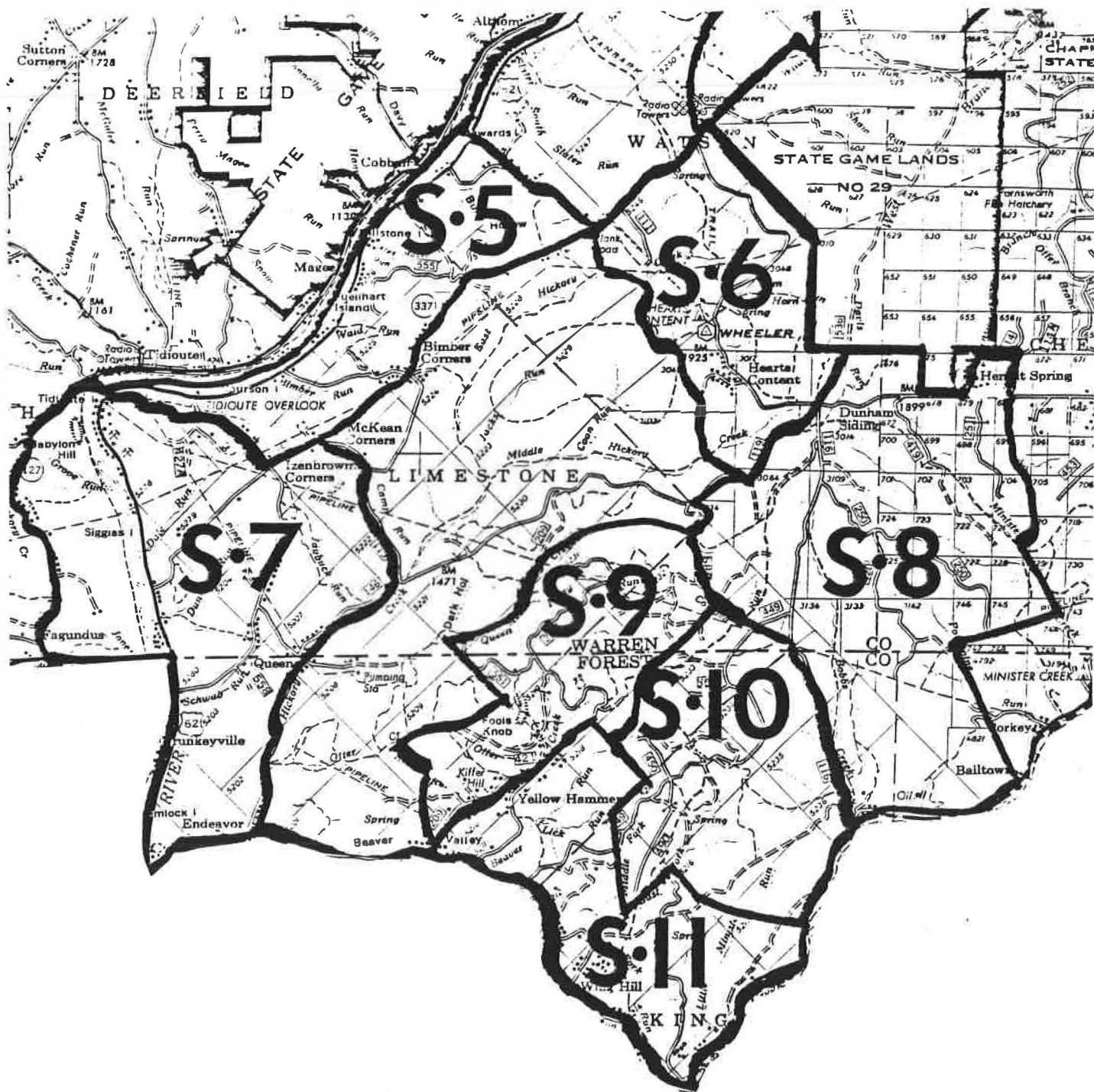
Map 11.--1987 Gypsy Moth Egg Mass Survey Entomological Areas,  
Allegheny National Forest, Sheffield Ranger District







Map 13.--1987 Gypsy Moth Egg Mass Survey Entomological Areas,  
Allegheny National Forest, Sheffield Ranger District





This is a detailed topographic map of the Limestone region in Tennessee. The map shows the Limestone River flowing through the area, with numerous creeks and tributaries. Key features include:

- Geographical Features:** Limestone River, Arrens Forest, State Game Lands, Chapman State Park, McKean's Corners, Punkysville, and various creeks like Bully Hollow, Middle Creek, and Yellow Hammer.
- Land Parcels:** Numerous numbered land parcels are shown, including 50, 52, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200.
- Infrastructure:** Roads, trails, and railroads are shown, including the Limestone River Railroad and the Limestone River Turnpike.
- Settlements:** Punkysville, McKean's Corners, and various other small settlements are marked.
- Topography:** Elevation contours and various geographical features like hills and valleys are indicated.

The map is oriented with North at the top. The Limestone River flows from the north towards the south, with many smaller creeks branching off from it. The land parcels are numbered in a grid-like fashion, with some areas being larger and more prominent than others. The map also shows various other features like bridges, dams, and small structures.

Map 15.--1987 Gypsy Moth Egg Mass Surveys, Miscellaneous Areas Sampled,  
Allegheny National Forest

